CHAPTER 2

HISTORY OF FLOODS

2.1 General

Floods are a natural and inevitable part of life in the United States. Some floods are seasonal—as when winter or spring rains and melting snows drain down narrow tributaries and fill river basins with too much water, too quickly. Others are flash floods—raging torrents that rip through river beds after heavy rains, surge over the river banks, and sweep away everything in their paths. The transformation of tranquil rivers into destructive floods occurs many times each year across the country. No region of the United States is completely free from the threat of floods, and they may occur at any time of the year (see Table 2-1 for notable flooding that has occurred in the United States).

2.2 Flood Warning History

The NWS provided its first local flood warning capability shortly after World War II. The initial warning system was based on simple tables that related storm rainfall quantities to specific stage heights. Although these tables oversimplified the flood forecast generation process, they provided additional lead-times and effectively produced some reduction in flood damages and loss of life. Many of the manual systems still exist today in portions of the United States, particularly in small communities. In the early 1970s, an automated LFWS was installed by the U.S. Bureau of Reclamation (USBR) in northern California.

Also in the early 1970s, the NWS Office of Hydrology developed and implemented 70 flash flood alarm systems to communities throughout the country that are prone to flash floods. Growth of the automated LFWSs was slow until the late 1970s when the NWS California-Nevada River Forecast Center (RFC) developed the Automated Local Evaluation in Real Time (ALERT) system. Since then, ALERT has spread throughout the United States and into several other countries. During the late 1970s and early 1980s, the NWS, under congressional mandate, planned and developed regionally coordinated LFWSs in Appalachia called the Integrated Flood Observing and Warning System (IFLOWS).

Presently there are over 400 LFWSs in the United States, principally in California, Arizona, Texas, and the Appalachia area. The number of automated LFWSs is expected to increase as additional serious flash flood issues are addressed. Several Federal agencies have become more involved in automated LFWSs as a mechanism to combine structural/nonstructural solutions to the flash flood problem.

Flash floods are only one type of flood event requiring special consideration among the NWS, state and local governments, and the general populace. Main channel flooding also poses a threat to life and property in several areas of the country each year. The NWS's 13 RFCs have hydrologic forecasting responsibility for the main stem rivers and their larger tributaries. RFCs collect hydrometeorological data from a variety of sources, including many

LFWSs, for input to river basin models. At many points, particularly along larger streams, daily forecasts of river stage and/or discharge are routinely prepared for river-related activities such as navigation and water management. Reservoir inflow forecasts aid Federal, state, and local agencies in the operation of these reservoirs for water management activities. Forecasts of water temperatures and ice formation and breakup are prepared for selected locations. Forecasts of seasonal snowmelt or water-year runoff are prepared by the NWS and the Natural Resources Conservation Service (NRCS), formerly Soil Conservation Service, during appropriate times of the year.

RFC hydrologists make appropriate modifications to the hydrographs generated by the model before distributing the forecasts to the local weather offices. The Weather Forecast Offices (WFO)[1] then prepare routine river forecasts and event-driven flood bulletins to the public for more than 3,000 specific locations across the United States. The flood products include forecasts of height and time of flood crest, when the stream is expected to overflow its banks, and when it will recede within its banks. Crest forecasts can be made a few hours in advance for communities on streams draining small areas, but it can be 2 or more weeks in advance for downstream sites on large rivers.

[1] The term "WFO" doesn't officially apply to the office until its Advanced Weather Interactive Processing System (AWIPS) is commissioned and Initial Stage 2 operations commence. In the two-tier, pre-NWS modernization and associated restructuring configuration, meteorological offices are referred to as Weather Service Forecast Offices (WSFO) and Weather Service Offices (WSO). With acceptance of the Next Generation Weather Radar (NEXRAD), those offices destined to become WFOs become NEXRAD WSFOs (NWSFO) and NEXRAD WSOs (NWSO), respectively, and begin Stage 1 operations. However, to simplify the terminology in this document, all of these offices are generically referred to as WFOs regardless of modernization stage.

Table 2-1. *Disastrous Floods in the United States*

The perspective of disastrous floods in the United States is evident from some of these historical examples:

Date	Location and Cause	Deaths	Damage ($ in millions)
Sept 1996	North Carolina, Virginia, West Virginia, Maryland, Pennsylvania - Hurricane Fran	34	3,200
Aug-Sept 1996	Puerto Rico - Hurricane Hortense	21	375
Feb 1996	Washington, Oregon, Idaho, and western Montana - 29 inches rain in less than 1 week	13	1,000
July 1994	Georgia, Alabama, and Florida - Tropical Storm Alberto - 21 inches of rain in 24 hours	33	750
May-Aug 1993	Mississippi River - heavy, prolonged rain (2-3 feet) over parts of nine states	48	15,000
Jun 1990	Shadyside, Ohio - 5 inches rain	26	8
May 1990	Texas, Oklahoma, Arkansas, and Louisiana - torrential rains over several weeks	13	1,000
Jan 1990	Washington and Oregon - heavy rain	3	60
Jun 1989	Texas and Louisiana - Tropical Storm Allison	11	500
May 1989	Texas and Louisiana - up to 16 inches rain	11	10+
Sep 1988	Florida - 18 inches rain	2	50+
Jul 1988	Texas - 10 inches rain	6	1
Feb 1988	Louisiana - 12 inches rain	3	2
Jan 1988	Hawaii - 23 inches rain	0	35
Dec 1987	South-central United States - 4 consecutive days heavy rains	4	17
Nov 1987	Louisiana - 21 inches rain	0	6
Aug 1987	Illinois and Wisconsin - remnants from tropical depression	4	100

Date	Location and Cause	Deaths	Damage ($ in millions)
Oct 1986	Michigan, Illinois, Missouri, and Kansas--up to 20 inches rain over several weeks	10	2,000
May 1986	Pennsylvania - heavy rain	9	23
May 1986	Missouri	3	50
Nov 1985	Appalachia - Hurricane Juan - 6 days rain	63	1,000
Aug 1985	Cheyenne, Wyoming - 6+ inches rain	12	65
May 1984	Tulsa, Oklahoma - 9.5 inches rain	13	130
Oct 1983	Southeast Arizona	10	100
Aug 1982	Kansas City, Missouri - 12 inches rain	4	30
Jan 1982	Central California	30	300
Oct 1981	Texas and Oklahoma	5	200
Feb 1980	California, Arizona, and New Mexico	22	300
Aug 1978	Central Texas - Hurricane Amelia	33	100
Nov 1977	Taccoa, Georgia - dam break	40	N
Sep 1977	Kansas City, Missouri - 13 inches rain	25	100
Jul 1977	Johnstown, Pennsylvania - 11 inches rain	76	200
Jul 1976	Big Thompson, Colorado - 12 inches rain	139	50
Jun 1976	Teton Dam, Idaho - dam failure	14	1,000
Jun 1972	Northeast United States - Hurricane Agnes	120	4,000
Jun 1972	Rapid City, South Dakota	254	N
Feb 1972	Buffalo Creek, West Virginia - dam break	118	N
Aug 1969	Virginia - Hurricane Camille	153	100
Jun 1903	Heppner, Oregon	247	N
May 1889	Johnstown, Pennsylvania - dam failure	2,000+	N

Note: N = damage not available